

WCX 2025

On tap: SDVs, Toyota's
Woven City, Stellantis design



Elaphe has new hope for in-wheel motors

Reviewed: Ioniq 5, Murano, 4Runner

Q&A: Siemens' advances in Industrial AI





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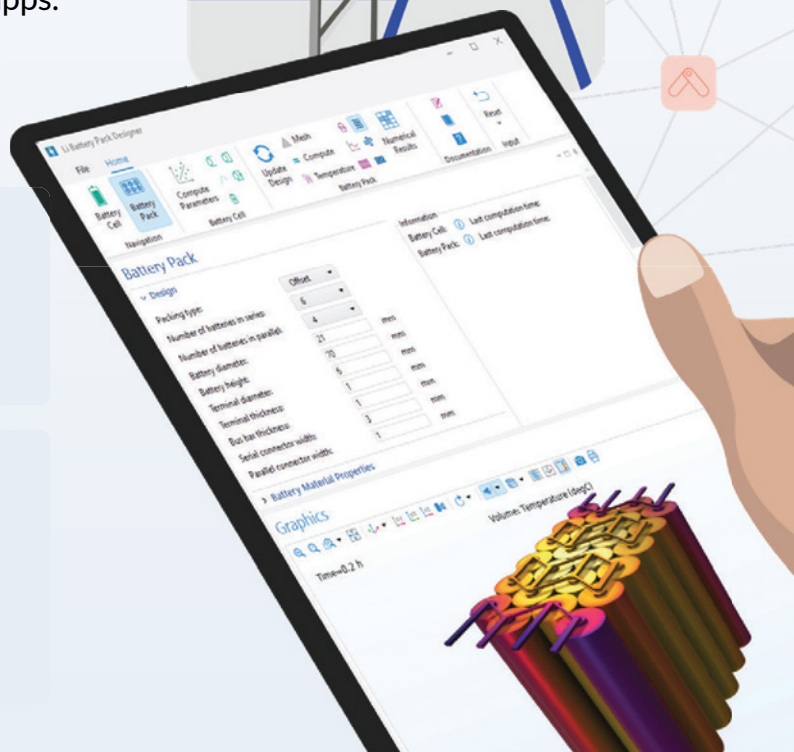
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Despite the industry's significant economic headwinds, there is plenty to learn about and be inspired by on tap at the SAE World Congress. (Image: SAE)

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EDITORIAL

Absolutely nothing's changed

A chaotic wrecking ball continues to smash not just the world's political stability but the very idea of a rules-based society. If only we could find a way to figure out what the automotive industry is truly interested in when it comes to long-term survival and planning. If only...

"Polestar CEO Michael Lohscheller has called on the UK government for stability after years of changing targets on the ban of cars and vans with internal combustion engines."

The Independent. January 2025.

"The ACEA will now focus on improving regulatory conditions, working towards decarbonization and championing free, fair and rule-based international trade, [Mercedes-Benz chairman Ola] Källenius said in the statement."

Reuters. December 2024.

"Stability is key for investment."

The Alliance for Automotive Innovation. December 2024.

"The 2035 target gives a clear direction that will allow us businesses, alongside all other stakeholders, to focus on delivering the transformation required. It also provides the much-needed investment certainty on the future of the automotive industry in Europe."

Automotive executives via industry-for2035.org. September 2024.

"The industry can be pushed „really far in one direction, potentially, and then be told, scratch that, go in a very different direction. That may average out at the 50-yard line, but it's a very inefficient way to get there."

Tom Stricker, Toyota Motor North America group vice president of sustainability and regulatory affairs. August 2024.

"Opinion: U.S. car makers need stable standards"

The Detroit News. July 2019.

"DOT will intensify its efforts to develop well-designed and globally-consistent regulations for [Automated Driving Systems]." **Understanding NHTSA's Regulatory Tools. October 2017.**

"[We must] eliminate uncertainty." **Renault-Nissan CEO Carlos Ghosn. March 2013.**

"Our engineers sometimes feel as if they are forced to play European soccer on an American baseball diamond by Japanese sumo wrestling rules. We're not fighting against environmental regulations. Our ultimate goal is emission-free driving. It's just that this 'patchwork quilt' of regulations doesn't necessarily support us in getting there." **Daimler CEO Dieter Zetsche. Automotive News. May 2008.**

"This tough, nationwide, proposed fuel economy increase will be good for both consumers and energy security. While these increases will present a challenge, it is critical that automakers and consumers have the certainty that this nationwide, 50-state fuel economy rule provides."

The Alliance for Automotive Innovation. April 2008.

"Current and proposed new safety, emissions, and damageability standards for the 1976, 1977 and 1978 model cars would add about \$750 per car or \$8-billion a year to consumer expenditures, if we could meet them all... I believe we should have a five-year moratorium on new safety, damageability and emissions standards starting Jan. 1." **Ford Motor Company president Lee Iacocca. April 1975.**

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The world re-regionalizes

As the industry grapples with the prospect of forced changes to the automotive trade structure, it is important to take a step back and survey the drivers of vehicle import/export flows. As you read this, this author has little confidence that all the U.S.-driven trade and tariff actions initiated early in 2025 are behind us. As electrified vehicles gain favor (depending upon the market dynamics), governments are focused into building their own supply chains to reduce trade dependency and spur regional employment. The old adage of build where you sell is the political mantra.

As markets such as China, U.S. and the European Union maintain or become more protectionist (especially as electrified vehicles gain favor), what is the future of inter-regional vehicle flow?

At **S&P Global Mobility**, we have an interconnected forecast where we track light vehicle sales globally by production region. The world is divided into seven vehicle regions: North America, Greater China, Japan/Korea, Europe, Middle East/Africa, South America and Southeast Asia. Over a thirty-year period, vehicle flow historically has changed little. In year 2000, roughly 15% of global light vehicles were interconnected. This rose two share points to 17% in 2010 and dropped to 16% in 2020. In essence, the overall rate has been quite stable, though the real story is what's happening beneath the waves. According to the S&P Global Mobility Light Vehicle Sales Forecast Import Module, our 2030 forecast may rise to over 17% inter-connected volume. Why is this rising through this decade and not declining? It's the China factor.

Over the 35-year period, Mainland China's share of global interconnected volume surged from virtually zero in 2000 to -4% of global



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Many countries are eying the benefits of incremental manufacturing jobs and lack of global trade dependency through increased internal volume.

volume. Several factors are driving this. Growth of Chinese OEMs in the European Union and Russia may reach 9% of Europe's volume by 2030. The importance of this shift cannot be underestimated. Even with several China OEMs building plants in Europe, almost 9% of their volume is slated to be imported from China.

Japan and South Korea are declining as sources for imports. The 30-year shift from over 8% of global volume in 2000 to ~5% in 2030 outlines the challenges that Japan & Korea will have as plants are built abroad and China continues to dominate export growth. Similarly, North America had started to emerge as an export source to the world (reaching 1.5% of global volume), though this level is starting to deteriorate as costs and vehicle mix gravitate volumes back to North America.

Outside of the aforementioned China factor, the world is trying to re-regionalize. In essence, build more where you sell. Back in the 1960s, as the industry grew, it rose from within with a number of regional OEMs such as **Toyota**, **Volkswagen** or **General Motors**. As these and other OEMs globalized they expanded their regional breadth to gain scale to build a truly global industry. Fast forward to today, many countries are eying the benefits of incremental manufacturing jobs and lack of global trade dependency through increased internal volume. An emerging challenge is the potential lack of economies of scale and ecosystem efficiency, though. There's another byproduct. While regions are becoming more internal, so are the OEMs. This lack of demand diversification is not optimal for global OEMs. This 'less is more' ideology (less dependency on other regions for volume) will continue — driving more industry volume challenges as we re-regionalize. ■



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PROPULSION

Elaphe readies in-wheel motors for OEM EVs after 2030



Elaphe shared its CES 2025 booth with Italdesign and its Quintessenza EV concept.

Elaphe unveiled what it claims is the first and only in-wheel electric motor (IWM) designed to fit existing EVs at CES in January. Elaphe Propulsion Technologies, a pioneer of in-wheel electric motor (IWM) technology, said its new IWM product line, branded Sonic, will start with the Sonic.1 a high-performance IWM designed to have high power density and fit into a 21-inch wheel alongside a conventional brake disc.

Elaphe is testing and demonstrating its IWM AWD and advanced controls in Sweden this winter. The direct-drive IWMs were added to an otherwise stock **Hyundai** Ioniq 5 AWD with the 77-kWh battery pack. The EV has a limited power output of 230 kW, with front-rear split of 30%-70% available power. Elaphe's base IWM technology is scalable, in radius and in axle, and has been previously tested by vehicle start-ups like **Lordstown Motors** and **Aptera**. At CES, the 23-inch wheel scalability study produced 300 kW (402 hp) peak power.

Luka Ambrozic, Elaphe's chief commercial officer, told SAE Media that the Sonic.1 could be used as a bolt-on solution to electrify the front wheels of an ICE application that doesn't have space or just to add more performance to an existing electric vehicle. The low-volume Sonic.1 is meant for higher-end street legal that are also taken to the track. "We're thinking **Ferraris, Lamborghinis, Bugattis**," he said. "Anything above \$100,000 can actually benefit from this." Elaphe's IWM's can deliver their full torque in 4 ms.

Elaphe is developing other IWMs for mass-market vehicles but is doing that with OEM partners working on a new platform. Ambrozic

said these vehicles will not arrive in the marketplace until the 2030s. While performance is the goal for the Sonic.1, Elaphe is tuning its mass-market IWMs for efficiency, cost and safety. Elaphe said its IWMs have wheel control that's 20 times faster than competitors, up to 10 kilohertz, or 10,000 times per second. Because this precision can be controlled in both directions independently, the system can provide a 10% increase in acceleration, along with improved slip and traction control, increased lateral performance and reduced braking distance (by 10 to 15%).

Ambrozic said the cost for using Elaphe's IWMs result in a vehicle that's in "the same range as any other powertrain in this segment" and that the higher costs for the IWM themselves are balanced out by cost reductions at the vehicle level. The IWMs also provide packaging benefits but the downside is, of course, added unsprung mass to the wheels. "Since we are working with the OEMs, we know that it's manageable and that the benefits for those OEMs are higher than the unsprung mass that's added," Ambrozic said. Actuators, ABS systems and active suspension components could all be removed or reduced since the IWMs can perform these tasks. Overall, Ambrozic said Elaphe sees total reduced platform costs of up to 30%.

"Those benefits are our long-term plan," he said. "This is why we're in the game. We want to make cars better and cheaper and more flexible. Consider in-wheel motors not as a powertrain, [but] really an enabling technology for you to do software-defined dynamics

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and chassis control.”

Elaphe shared its CES booth with **Italdesign** at CES, a booth dominated by a large (and technically drivable) concept EV called the Quintessenza. With four IWMs, the Quintessenza produces 500 kW (671 hp) at each of the rear wheels and 300 kW at the front wheels.

Ambrozic said from an engineering perspective what’s been most exciting working on IWMs is that they’ve been discovering things with near-weekly regularity for the last five years now.

“When you don’t have this kind of control frequency, you really can’t explore anything,” he said. “But now, when we started to explore, we’re continuously finding new functions, like how to artificially decrease or increase grip, that we can vibrate everything to create sound and vibrations on the chassis, some haptic feedback, just by vibrating parts in the tire.

Ambrozic said the kind of specific,



Elaphe’s 23-inch wheel scalability study on display at CES 2025 produced 300 kW peak power and 2500 Nm peak torque.

targeted haptics that Elaphe’s IWMs can give vehicle occupants could play an important role in keeping OEM brands distinct.

“You feel it in your butt, you feel it in the pedals, you feel it in the steering wheel, and we can do that directionally,” he said. “The brands, when they go elec-

tric, they want to keep some of that character, or they want to develop a new kind of character for a particular product line that’s unique to them. It’s like a gimmick, five minutes of an engineer who had this idea, but it turned out to be one of the key characteristics.”

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TESTING

Case study: accuracy is key in AHP Hydraulics' new ball joint tester

Belgian solutions integrator **AHP Hydraulics** faced a certified stumper of a challenge from client **SIDEM NV**, which develops and produces automotive suspension and steering units. Ball joints play a critical role in these suspension units and thus require rigorous testing to ensure that production batches can be QA-approved and sent into supply. The client had a ball joint tester from another company, but it wasn't exact enough to meet the application's needs.

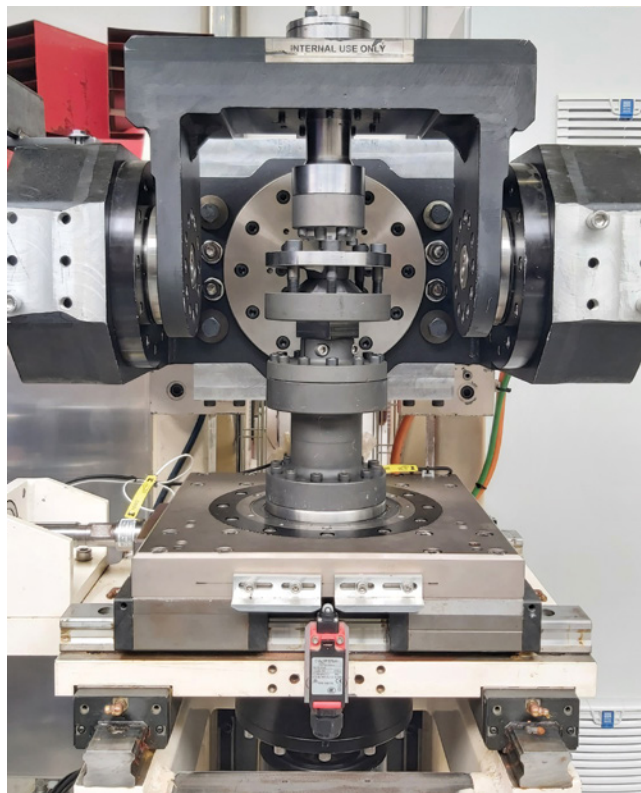
AHP's solution uses two hydraulically controlled axes: a horizontal (y-axis) and a vertical (z-axis), both with linear actuators and electric torque axes. The hydraulic cylinders deliver position and force feedback into a programmable user-machine interface for better precision and reliability.

SIDEM NV told AHP it wanted a force tolerance of ± 100 newtons over a total range of 6000 newtons, said AHP Hydraulics automation engineer Ewout Reuman. On the rotation, it specified a total tolerance of 0.5 degrees over a total range of 90 degrees while cycling at 4 Hz.

"The rotational motion and the hydraulics had to be very accurate, and there I was on Google and YouTube trying to learn about the subject, quickly realizing how much I needed to pick exactly the right control product," Reuman said.

Identifying the unknowns

AHP's first step was procuring the client's current ball joint tester and disassembling it into the mechanical parts. This allowed them to examine the electronics and consider how to improve the horizontal axis (y-axis) and vertical axis (z-axis) of hydraulic circuits and components. Ultimately, AHP rebuilt the tester from bottom to top and re-engineered the electronics and software. That included scrapping the conventional PC for motion control in the electrical cabinet and replacing it with a Beckhoff PLC functioning as the master and the Delta



AHP ball joint tester system.

Motion controller as a slave for the hydraulics.

Reuman found himself tasked with handling the ball joint tester's electrical engineering and software programming. Once he understood the accuracy needed in the solution and why prior attempts had fallen short, he reached out to **Delta Motion**, which agreed to send a representative to Brussels to work alongside the AHP team.

AHP procured Delta's RMC75E dual-axis motion controller with Ethernet connectivity for communication with the system's master PLC. Reuman paired this with Delta's MA2 magnetostriuctive I/O module and the AP2 analog I/O module for measuring force feedback from load cells.

AHP ball joint tester control cabinet featuring the Delta RMC75E motion controller. The two linear axes are controlled by a hydraulic servo valve and cylinder. The complete testing machine is controlled by a PLC, with the PLC providing set points and controlling both the rotational axes as well as the Delta Motion controller via an Ethernet IP connection. Within that PLC/Delta loop, in which the Delta serves as a network slave to the PLC master, the Delta RMC controls the hydraulic accuracy, error correction, and other factors.

The nature of the directional forces within the apparatus



AHP ball joint tester control cabinet featuring the Delta RMC75E motion controller.

led to some vexing challenges. Imagine the central ball joint continually rotating back and forth within its housing while being pushed on both from the side and below, all while a boom allowed the ball joint to swing back and forth, and the give within that joint housing allowed the ball to be constantly off-center. With these multiple forces interacting, there was never a perfect center state; the system was always in a state of deviation and change. Asynchronous force testing was always inaccurate. That alone was something AHP's client could accept, but the deal breaker was the system's propensity to show force steadily growing over time. The customer demanded that asynchronous force be stable.

"Going into the project," he adds, "I wasn't aware how much influence that would have. I would get immense overshoots and undershoots, so I was constantly retuning the system when test frequencies, amplitudes, or oil temperature changed."

Figuring out the fix

The situation called for rethinking the tuning. Delta suggested that adaptive amplitude control could fix AHP's precision and reliability. AHP could measure every sine wave cycle and compare it to the target. Then the controller adjusts the amplitude and offset for the following sine wave cycle until the target and actual forces coincide.

Reuman identified a repeating wave pattern in the force curve. Delta's sample project provided the foundation for implementing adaptive amplitude control, and Reuman added the wave pattern solution he developed. If all axes were synchronous, then the peaks would be flat. Based on the input frequencies, Reuman used Delta's RMCTools software to identify the wave pattern in the wave crests and troughs and arrive at a method of offset and amplitude gains to compensate for it. For example, if the highest peaks occurred with every fourth wave, then the instance of one peak wave could inform how to compensate for the next fourth peak. (In reality, Reuman ultimately compensated for every sixteenth peak.) This dynamic approach proved far better than AHP's previous approach of applying one set of offset and amplitude gain values for every wave.

The combination of adaptive control and PID tuning was the missing key. Reuman mapped the changes he worked out in RMCTools to his own application. No additional sensors or other equipment were needed to successfully implement adaptive control. It simply dropped into place via software.

With Delta's RMCTools software and support, Reuman had his sine wave, complete with initial tuning, running "literally in a couple of hours."

"One really helpful feature with Delta Motion is that it can autotune," Reuman said. "During autotuning, it measures the system behavior and creates a system response. Based on the Actual Position, Target Position, and Control Output, the Auto Tuning algorithm calculates a system response model. That's very important when controlling hydraulics because there are so many unknown factors in the system."

Reuman pointed to oil temperatures and the temperature fluctuations that impact system behavior. The variation in oil



Graph from RMCTools showing asynchronous AHP ball joint test data for the Fz (vertical push/pull) axis. Note the rise and fall in the wave peaks.

temperature caused large fluctuations in system response. Implementing a Gain Schedule enabled the controller to dynamically adjust control response based on the system (or in this case, environmental) conditions. The RMC Motion Controller has the ability to dynamically adjust parameters to maintain the required performance levels.

The precise results needed

It took AHP roughly one week to configure the hydraulics and another one to two weeks to fully tune and integrate the Delta RMC with the entire ball joint testing system. Like many solution integrators, AHP isn't privy to whatever ROI metrics the client used for its ball joint tester project. However, in a sense, the ROI boils down to a 0 or 1 proposition. The automotive manufacturer can do something it simply couldn't before. Alternatively, ROI might be estimated using hypothetical failure rates.

"You have to imagine that when a batch is coming off the production line, and they are distributing those parts all around the world, a batch with production failures — because it wasn't well tested — is going to cause very high expenses," Reuman said. "That's why we picked the best components and partners for this job. There are so many factors in hydraulics that aren't the same for electric-driven axes."

Tim Gessner is director for Business Development at Delta Motion.

ENERGY STORAGE

Mitsubishi Fuso announces energy storage demonstration

Mitsubishi Fuso Truck and Bus Corporation has announced it will conduct a joint demonstration of its Battery 2nd Life initiative this year. This initiative will be jointly conducted with CONNEXX SYSTEMS Corporation and will repurpose used batteries from Mitsubishi eCarter trucks to build energy storage systems.

According to Mitsubishi, CONNEXX will remove the used batteries from end-of-life eCarter trucks and repurpose them as power sources for what CONNEXX has dubbed their EnePOND EV Charger energy storage systems. These units have integrated EV chargers developed by CONNEXX that can reportedly reduce the load on the existing power grid while allowing for DC fast charging of multiple EVs simultaneously. CONNEXX also noted that these units enable EV charging during power outages.

According to Mitsubishi, repurposing used EV batteries accelerates the expansion of charging infrastructure while reducing overall costs and extending the lifespan of the battery. The first installation of this system will be located at Muko City, Kyoto Prefecture City Hall and will be used to charge the city's EVs. Another EnePOND charger will be installed at Mitsubishi's Kawasaki Plant. Mitsubishi and CONNEXX SYSTEMS expect this demonstration to verify the viability of this system with a targeted commercial availability of 2026.



Under this partnership, CONNEXX will remove the used batteries from end-of-life eCarter trucks and repurpose them as power sources.

"Batteries hold significant value in EVs and the number of used EV batteries and demand for processing them is expected to rapidly increase with the advancement of electrification," Mitsubishi said in a release. "When these batteries complete their roles in other applications, the materials will be recovered for use in new products. Mitsubishi aims to establish a circular economy of batteries to maximize their material value, reduce the total cost of EVs, and further accelerate the shift to EVs."

Mitsubishi also announced the construction of a pilot facility in 2024 for re-

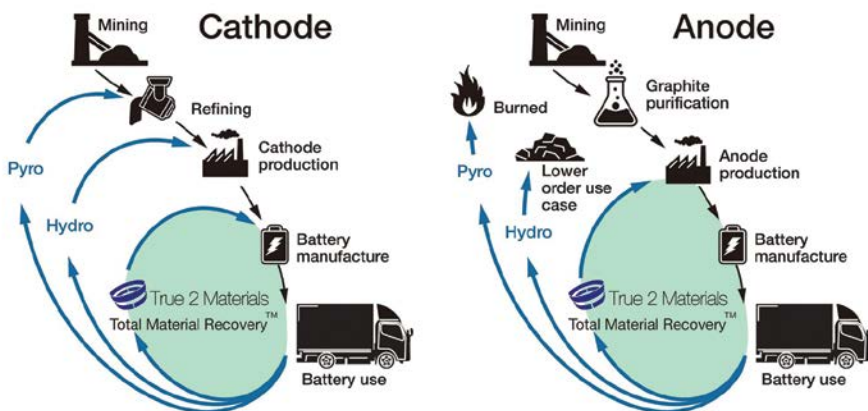
covering materials from EV batteries.

Mitsubishi stated that it had partnered with True 2 Materials to construct the facility which will recover anode, cathode and electrolyte materials. The facility will be located at its Kawasaki Plant to test the effectiveness of the T2M Total Material Recovery Process. The aim is to commercially maximize the value of battery materials while also reducing the overall cost and environmental impact of EVs.

Mitsubishi will first evaluate commercial viability in Japan but is open to the possibility of overseas expansion. Mitsubishi intends to maximize the value of battery materials by developing effective retreatment processes and thereby reducing the total cost of EVs.

T2M's Total Material Recovery process reportedly retains usable anodes and cathodes while minimizing loss of raw materials and their value and reducing environmental impact. The TMR process uses nano-level molecular techniques and is different from conventional pyrometallurgy and hydrometallurgy battery recycling. TMR states this technology allows recovery of up to 99.9% of all EV battery resources, a higher percentage than conventional methods, thereby maximizing battery resource value.

Matt Wolfe



According to Mitsubishi, repurposing used EV batteries accelerates the expansion of charging infrastructure while reducing overall costs and extending the lifespan of the battery.

CYBERSECURITY

Building Resilient SDVs: Secure by Design in the automotive industry

Modern vehicles contain upward of 100 million lines of code and growing. The emergence of autonomous vehicles and software-defined vehicles (SDVs) means cars often run 100-plus applications, turning them into “software on wheels.” That brings security risks.

There are lessons to be learned from Secure by Design principles and software development best practices that can address the risk to automotive systems, protecting everything from infotainment systems to autonomous software platforms and even specific ECUs.

Implementing security: standards and frameworks supporting Secure by Design

Secure by Design is a collection of development practices embedded within the software development lifecycle to proactively address and reduce vulnerabilities before they can be exploited.

The automotive industry faces significant challenges in implementing software development best practices due to its intricate supply chain.

In recent years, a number of standards and certifications have emerged with the goal of supporting security within automotive software development. These include the AUTOSAR standards, which established a standardized software architecture for automotive ECUs and a common framework for automotive software development to enhance collaboration between OEMs and suppliers.

The POSIX (Portable Operating System Interface) also plays an important role in automotive software security, supporting the development of secure vehicle software architectures for real-time operating systems, SDVs, and ECUs.

Additionally, ISO 26262, though primarily focused on safety, includes guidance for software development and ASIL (Automotive Safety Integrity Level) certification for safety-critical code, such as for autonomous braking and Advanced Driver Assistance Systems.

Examples of applying security to automotive software:



Modern vehicles contain upward of 100 million lines of code. More software means more opportunities for attackers to target vulnerable systems and code.

ECUs and autonomous software

Today's vehicles often have up to 100-150 ECUs per vehicle. These embedded systems use real-time operating systems that software applications are built on. ECUs in vehicles are primarily programmed using C and C++ due to their real-time performance and efficiency in resource-constrained environments.

However, C/C++ is memory unsafe, leaving these systems vulnerable to memory-based attacks. A successful exploit of a memory-based vulnerability can enable remote code execution and the compromise of critical systems, leading to vehicle safety and reliability concerns.

A key Secure by Design principle is to use memory-safe languages wherever possible or to apply mitigations to prevent successful exploitation. AUTOSAR standards include best practices for protection against memory corruption attacks and guidance to develop AUTOSAR-compliant code and safety-critical software (ASIL) developed using these languages.

Tight coordination with an RTOS provider to ensure memory-safe best practices are followed and mitigations are in

place, as well as sound discipline around application scanning and fixing and patching processes, are essential to ensure vehicle software is resilient against attack.

Until over-the-air (OTA) updates become consistently mainstream, achieving memory safety in applications built on RTOS, whether OTA updates are available or not, is necessary for cybersecurity.

Infotainment systems

Because of increasing connectivity, infotainment systems are high-value targets on SDVs and connected vehicles. Infotainment systems are both attack vectors to get data and location and on-ramps to access other vehicle systems, like ADAS and key engine control units.

The underlying operating systems for infotainment systems and telematics often use Android. Following the Secure by Design principle of sourcing secure software components is important for protecting these systems. Ideally, an OEM or component supplier should build the Android operating system from source, giving control over the components that are incorporated and compiled. By building from source, they can also insert security protections, like runtime exploit prevention, to protect software, including memory-based vulnerabilities that are an easy access point into vehicle systems.

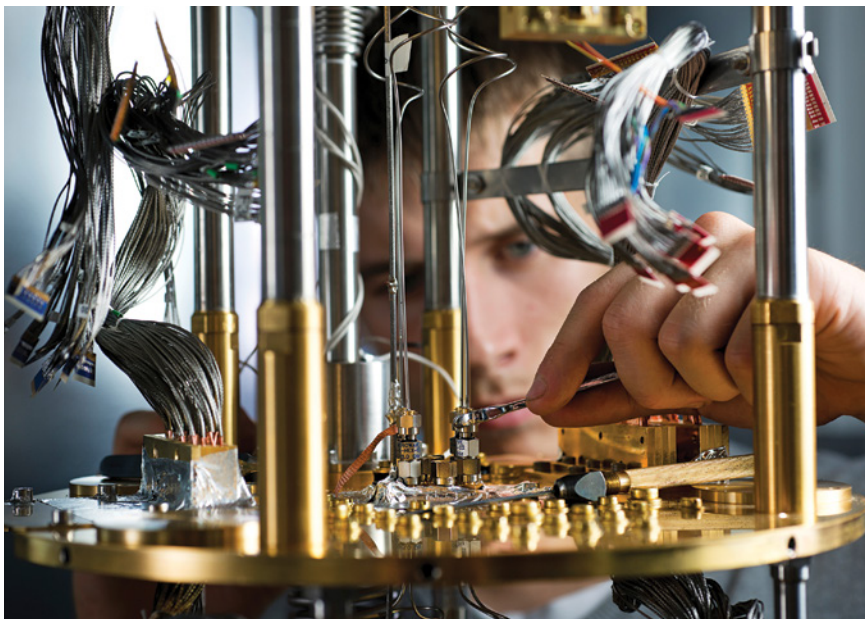
While safety is often the primary focus for vehicle manufacturers and OEMs, with the software-driven vehicles of today, security is becoming a critical component of safety. When you consider the millions of lines of code behind connected systems, ADAS, and autonomous vehicles, the potential to exploit that code has increased exponentially.

By following software development best practices, manufacturers can build more resilient, trustworthy vehicles that protect both consumer data and critical system functionality.

Joseph Saunders is founder and CEO of RunSafe Security

SIMULATION

Accelerating materials development with quantum computing



Volkswagen said in 2021 that researchers believed quantum computing has the potential to open new areas of exploration. The work continues.

As most engineers pursue ways to improve material properties such as longevity, corrosion resistance and eco-friendliness, quantum computing is emerging as a groundbreaking technology to accelerate new material development.

The automotive engineering industry relies heavily on materials, from the metals used in components and structural parts to the polymers in casings and specialty chemicals like paints and coatings that finish products. The performance and longevity of these materials directly influence the final machines' quality and sustainability. Imagine paints that adhere better or last longer, metals that resist corrosion more effectively, or batteries that store more energy and charge faster. These are not-so-distant realities with quantum computing.

Quantum computing operates on the principles of quantum mechanics, offering new computational capabilities beyond the scope of classical computers today. These new capabilities include enhanced molecular simulation which is

critical for simulating complex chemical processes and which poses a significant challenge for traditional computational methods. For materials science, this means we're on the cusp of the ability to innovate and develop materials at a much faster pace.

Because of this, one of the areas where quantum computing is expected to make a significant and immediate impact is the development of new materials, including green products and solutions that reduce environmental impact. For instance, the design of polymers that minimize the probability of causing microplastic pollution could assist the industry's approach to sustainability. Similarly, developing metals less prone to corrosion would enhance the durability and lifespan of vehicles, reducing waste and the need for frequent replacements.

Paint chemistry is another area suitable for innovation with quantum computing. By understanding the quantum mechanical interactions at play, researchers can develop formulations that

last longer and offer improved adhesion, resistance to environmental damage and lower toxicity. These advancements would improve product aesthetics and durability and contribute to environmental sustainability.

Another example of quantum computing's potential in materials development is in the development of better energy storage through advanced battery chemistry. Enhanced battery technologies would directly impact electric vehicles, opening new possibilities for energy integration and efficiency. For instance, **Volkswagen Group** is using quantum computing to simulate and optimize battery materials and **BMW Group** is using the technology to find the optimal architecture of electrical and mechanical systems (**Classiq** is collaborating with BMW).

It's essential, however, to acknowledge that the transition to quantum-enhanced materials is long. Quantum computing is an emerging field, with materials science expected to be among the first to benefit from its advancements. For automotive engineers and manufacturers, this brings promising future choices and opportunities for innovation.

In preparing for this quantum leap, automotive engineers must be informed and ready for the changes ahead. The growth of new material options powered by quantum computing will affect manufacturing processes and open new avenues for product differentiation and value creation.

Quantum computing promises to be a game-changer for materials development. By enabling the creation of materials with superior properties and environmental benefits, quantum computing will play a pivotal role in driving innovation, enhancing product quality and promoting sustainability in the automotive manufacturing industry. The future of materials science is quantum, paving the way for revolutionary advancements in automotive engineering.

Simon Fried is VP of marketing and business development at Classiq.

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SUMMIT

April 22-23, 2025

The two-day Battery & Electrification Summit returns this April to discuss the latest battery and electric power developments impacting the mobility industry.

Join the FREE event to learn how teams from Microvast, Electreon, RapidEVcharge, Classiq, and more are facing down critical challenges and charging ahead in the global, ongoing quest for battery design innovation.

Topics include:

- A New Administration's Effect on EVs
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- AI for Advanced Battery Management Systems
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- Quantum Computing for Better Batteries
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Hear from these pioneers:



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Voltpost



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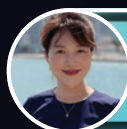
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Director of Quantum Enterprise Development,
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WCX 2025 once again returns to Huntington Place with more than three floors of events and seminars and a nearly full floor of exhibition booths.

As the industry grapples with volatile economies and competition from China, WCX 2025 speakers focus on how engineers are forging ahead and keeping skills relevant.

by Chris Clonts

The national and global economy may face turbulent times for the near future, but the show goes on in automotive manufacturing. In addition to being a great place for engineers to upgrade their knowledge, the SAE's World Congress 2025, from April 8-10 at Huntington Place in Detroit, is also a good perch from which to view where the industry is headed.

One company undoubtedly focused on the future is **Toyota**, which at CES this year announced that its **Woven by Toyota** innovation city/campus had completed construction and was ready for engineers, designers and other key personnel to begin working there. The Woven City (Link) is meant to feature multidisciplinary collaboration in the exploration of future city services, energy sources, food and delivery and, yes, mobility.

John Absmeier, CTO of Woven by Toyota, the company that oversees the Woven City project, is keynote speaker at a fireside chat on April 10. It's also a chance to see the future of the organizing society itself, as the conversation will be moderated by Dr. Jacqline E-Sayed, SAE International's new CEO.

For his part, Absmeier told SAE Media via email that he views the ICE-to-EV transition the industry is in as exciting. "To maintain a competitive edge, traditional OEMs must embrace innovation," he said. "At WCX, I look forward to sharing how Woven by Toyota is accelerating toward a world with zero accidents. Through connecting people, vehicles, and infrastructure with human-centric innovations, we can build a safer environment that enhances well-being for all," he said. "Our vision at Woven by Toyota is fulfilled through the integration of Arene (Toyota's vehicle

software platform), AD/ADAS, and Woven City. Together, Woven City will be a mobility proving ground for testing and co-creation activities from mobility of people, goods, information and energy."

He also said the company is driving innovation via strategic partnerships, such with Joby Aviation and Interstellar Technologies, especially where it concerns potential advancements in safety and sustainability.

Advice for engineers

Since he's someone who has been at the cutting edge of technology from his tenure at supplier Lear to board member for Voltaiq, the enterprise battery analysis platform, we asked Absmeier if he had advice for already- and soon-to-be-working engineers to ensure they're ready to meet the industry's needs.

"Engineers can enhance creativity in problem-solving by cultivating a mindset that embraces ambiguity and uncertainty, recognizing that these elements often lead to innovative solutions," he said. "Engaging in diverse experiences and interdisciplinary collaborations can provide new perspectives and stimulate creative thinking."

He cited as one example Toyota's long history with 'kaizen (continuous improvement) and 'genchi gen-butsu' (going to the source). "Engineers at Toyota are



Jack Weast, VP and GM
of Intel Automotive



John Absmeier, Woven by Toyota's CTO

“Engaging in diverse experiences and interdisciplinary collaborations can provide new perspectives and stimulate creative thinking.”

encouraged to observe real-world challenges first-hand, whether on the factory floor or in real-world driving conditions.” He said that at Woven, the teams leverage data-driven development and simulation environments that allow for rapid experimentation, fast failure and rapid iteration.

Absmeier also said that AI and ultrafast computing are reshaping the industry, so engineers need to develop expertise in software-defined vehicles, data-driven



Toyota’s Woven City will soon be bustling with people from design, engineering and other fields, working collaboratively on new concepts. Some residents will be everyday users of the new products and services.

development and real-time simulation. To that end, Toyota has an integrated upskilling program called Dojo, which focuses “on reskilling employees into software engineers by providing hands-on training in areas such as programming, data, machine learning and AI.” It is handled by a talent management platform that can identify gaps in individual knowledge and apply training toward gaps in the company’s needs.

Facing China and a design mindset: other keynote

In addition to the United States tariff policy putting a lot of chop on the water, the industry is facing China’s already long-distance lead in EV manufacturing. In 2024, **BYD** passed **Tesla** as the world’s top EV maker, cranking out 4,500 more vehicles than the company ostensibly run by Elon Musk. And, increasingly, Chinese EVs are being lauded for their quality and innovation, especially in the battery space. The IM Motor L6 leverages a 130-kWh semi-solid-state battery to attain a range of 620 miles (997 km).

How have they accomplished this? On April 9, Jack Weast, VP and GM of Intel Automotive, will talk about his year of living in the country and observing its automotive industry. A fervent proponent of SDV architecture (Intel is developing SD architecture for the entire vehicle), he will cover the “996” approach of working 9 a.m. to 9 p.m. six days a week that China has outlawed with varying success. He’ll also talk about the topic of ‘neijuan,’ a state of such intense internal competition that a person (and society) can no longer evolve. It’s something China is so worried about that, as reported by The Guardian, the country’s premier, Li Qiang, warned against it at the Davos World Economic Forum last year.



Ralph Gilles, Stellantis' chief design officer.

steeply declining sales and high inventory. CEO Carlos Tavares shocked the industry by resigning in December after attempting a fire sale of what analysts said were overpriced vehicles, especially in the Jeep brand.

Ralph Gilles, **Stellantis'** long-serving and celebrated chief design officer, will speak May 8 in a chat hosted by former SAE President and current President and CEO of the Center for Automotive Research, Carla Bailo.

Elsewhere at WCX

The keynotes are all part of the Leadership Summit series of events at WCX. At press time panels were still being developed, but representatives from top OEMs and suppliers, including **GM, Honda, Lucid, Nissan** and **Amazon Web Services**, are scheduled to appear.

WCX's deep-dive Technical Sessions are led by experts and meant to bring attendees up to date on regulations, consumer metrics, emerging research and best practices across subjects including sustainability, EV batteries, smart manufacturing, vehicle software and hardware, materials and lightweighting and more.

For information, visit wcx.sae.org. ■

Earlier this year, at CES, Weast introduced intel's software-defined zone controller, which can manage power in a way that reduces overall power demand despite new AI and ADAS features.

Even before the new administration took office and started shaking the economy, Stellantis was facing troubles that showed up as

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Manufacturers must take the wheel to scale SDV success

Four suggestions on how OEMs should manage their SDV development process, from core competencies to leveraging AI.

by Aditya Pathak



Manufacturers should think of software development as an enterprise-scale operation akin to a supply chain.

The automotive industry is moving rapidly toward software-defined vehicles (SDVs), where cars are as much about software as they are about mechanics. The race to SDV is driven by progress in electrification, connectivity, autonomous driving technologies, and innovative ownership models. Unlike traditional cars, SDVs are designed to be as adaptable as smartphones, with software driving performance, safety, and personalization features. This shift is already underway, with projections showing that SDVs could make up an astounding 90% of vehicle production by 2029 – a massive leap from just 3.4% in 2021. This marks a powerful transformation, setting the stage for cars to become smarter, safer and more personalized over time.

But scaling SDV production will be no small feat. Integrating complex software with traditional vehicle hardware, managing constant updates, and ensuring quality across evolving models bring new challenges. For example, **GM**, **Volkswagen**, and **Volvo** have all faced major roadblocks in transitioning to SDV despite their desire to capture market opportunity. While these complexities have notably stalled automaker innovation efforts, manufacturers have a golden opportunity to support integration and quality management as we navigate the shift to digital. To truly scale SDVs, manufacturers must take a balanced approach to stay ahead of the curve, overcome roadblocks and drive the future of SDVs with confidence. Here are four ways they can succeed.

Focus on core competencies

Traditionally, vehicle differentiation was defined by mechanical and physical characteristics - combustion engines, mechanical transmissions and aerodynamics. Today, it's increasingly about software capabilities, like remote connectivity, customizable features and advanced driver-assistance systems (ADAS). However, scaling SDVs comes with new engineering and architectural demands. According to a report from **Deloitte**, connected vehicle data is expected to grow from 20 exabytes in 2022 to 117 exabytes by 2027. This means manufacturers

will need to manage massive volumes of data, analyzing and securing it in real time. At the same time, integrating advanced software into hardware systems requires expertise that many traditional manufacturers are still building. Core competencies like design, engineering, architecture and integrating technology stacks from multiple suppliers are essential for creating next-generation vehicles. Without these key skills, production delays, rising costs and compromised SDV quality could quickly erode consumer trust.

It's crucial to ensure ambition doesn't outpace practicality. We can learn from GM, which announced plans to transition to "100% virtual design, development and validation by 2025" in a presentation earlier this year. However, the automaker rightly clarified that they don't plan to shift entirely to virtual processes just yet. Instead, GM is focusing on adopting a range of tools and innovations to enhance its development capabilities and improve productivity. This recalibrated approach aligns with the need to build core competencies first, striking a balance between setting bold goals and ensuring practical execution as manufacturers navigate the complexities of scaling SDVs.

For their part, manufacturers need to invest in highly skilled development and engineering teams with deep expertise in software integration and vehicle electronics. These teams can bridge the gap between hardware and software, ensuring systems work seamlessly together – a critical factor for SDV success. However, manufacturers don't have to take on everything themselves. Partnering with external experts to handle non-core tasks, such as maintaining older vehicle generations, can free up valuable resources to focus on developing future versions of the vehicle

Manufacturers must take the wheel to scale SDV success



Aditya Pathak is VP and head of Automotive, Transportation & Logistics at Cognizant.

technology stack and advanced SDV platforms with next-generation features. This division of labor lets manufacturers maintain control over critical areas like design, engineering, and architecture, while external experts take charge of validation, verification and lifecycle management. This strategic approach almost guarantees innovation without overextending teams and positions manufacturers to lead in the competitive SDV market.

Strategize software and data monetization

Monetizing SDVs is one of the biggest opportunities for manufacturers to redefine how vehicles generate value. Unlike traditional cars, SDVs allow for ongoing revenue streams – think subscription-based features, over-the-air (OTA) updates and data-driven services. For example, manufacturers can offer upgrades like enhanced vehicle acceleration through in-vehicle subscriptions, which could bring in as much as \$900 a year per customer, according to Deloitte's report.

However, poor monetization strategies can hinder profitability and stifle innovation, leaving manufacturers to miss out on these lucrative recurring revenue opportunities. The key lies in building a strategy that creates sustainable value. Features like autonomous driving (AD) capabilities have moved away from futuristic concepts and are actively sought after by today's consumers. In fact, **McKinsey** reports that the automotive software market is projected to more than double,

reaching \$80 billion by 2030, with consumer demand fueling much of this growth in AD technology. This surge in interest presents a significant opportunity for manufacturers to deliver lasting value while aligning with evolving customer expectations.

To fully capitalize on this potential, manufacturers must build modular software systems that simplify updates and enable scalable, customizable features. For instance, offering drivers the option to temporarily upgrade performance on demand or unlock advanced navigation tools can provide more flexibility that resonates with modern customers. Usage-based insurance is another example, where drivers pay premiums based on their actual behavior, meeting market demand while driving steady revenue. These consumer-centric approaches will derive new strategies for income that complement the broader business model strategy.

Integrate quality management across the lifecycle

Reliability is the foundation of any successful SDV and depends on rigorous quality management throughout the entire vehicle lifecycle. Poor quality management can lead to deferred product launches, increased costs and missed revenue opportunities. Software-related recalls have skyrocketed, impacting nearly 10 million vehicles in 2022 compared to just 600,000 in 2012. These aren't minor inconveniences either – failing to comply with quality assurance requirements can lead to penalties exceeding \$165 million (as **Ford** learned in late 2024), not to mention the reputational damage.

SDVs have many components like infotainment systems, temperature controls, and autonomous driving features, all sourced from different suppliers and each with its own tech stack. Integrating these disparate elements into a seamless vehicle experience demands robust verification and validation processes. Edge platforms can further enhance this integration by delivering real-time, context-aware services like personalized navigation and proactive maintenance alerts. Done right, this ensures reliability, safety and consumer confidence.

To mitigate risks, manufacturers must implement quality checks and validation processes at every touch point, ensuring consistent performance that meets all regulatory standards. One effective strategy is adopting outcome-based engagements, where vendors are held accountable for delivering high-quality results. This approach helps manage defect leakage and aligns vendor performance with manufacturers' goals, upholding production standards across SDV lines.

At its core, quality management is about earning trust, especially in an industry where reputation is everything. Manufacturers should think of software development as an enterprise-scale operation, akin to a supply chain. Establishing software factories and leveraging specialized vendors can ensure scalable, secure, and maintainable software solutions for SDVs. When manufacturers commit to rigorous standards, they can deliver vehicles that meet regulatory demands, perform reliably and provide peace of mind to drivers.

Leverage AI to accelerate SDV success

Scaling SDVs means dealing with constant updates and complex software integrations, creating an overwhelming workload for traditional testing methods. AI-powered tools help manufacturers create a

It's crucial to ensure ambition doesn't outpace practicality.

fresh engineering approach that prioritizes scalability and efficiency.

AI-driven testing can automate essential processes such as test case generation, test coverage, and test data creation. This automation ensures comprehensive testing, reduces errors, and saves valuable development time. Generative AI takes these capabilities even further by creating synthetic test data that mirrors real-world conditions. It is particularly valuable when gathering real-world data is logistically or financially difficult. For example, AI can simulate challenging scenarios – like adverse weather conditions or traffic congestion – allowing manufacturers to evaluate performance without relying solely on physical testing. By embedding AI earlier in the testing lifecycle, manufacturers can accelerate development timelines by generating test scenarios and simulating sub-systems before the entire vehicle system is ready.

Predictive maintenance is another critical application of AI that can help vehicles stay on the road longer. By analyzing vast amounts of vehicle data in real time, AI can identify wear-and-tear patterns and flag potential issues before they escalate into failures. Additionally, advanced algorithms can validate that software updates meet legal requirements while ensuring compatibility across multiple components and systems. For manufacturers, this translates to fewer recalls,

lower costs, and a stronger reputation for reliability.

Beyond vehicle support, AI is revolutionizing the driver and passenger experience, bringing personalization and safety to new levels. In autonomous vehicles, these innovations include tools that can provide route updates, respond to passenger questions in a natural, human-like manner and even detect medical emergencies in real time. For example, some systems integrate audio, video and scanning technologies to interpret both verbal and nonverbal cues and better address travel context in conversation.

Manufacturers must plan to support vehicles for the next 15 to 20 years, making it essential to scale SDVs effectively. By embracing the right strategies, manufacturers can transition to a software-defined operation smoothly. When it comes to the scalability of SDVs, manufacturers are in the driver's seat. ■

Aditya Pathak is VP and head of Automotive, Transportation & Logistics at Cognizant.

TS-7100-Z

The TS-7100-Z is a compact, feature-rich embedded computer with a 2.8" touch display and a DIN-mountable enclosure. It includes Ethernet, USB, RS-232, RS-485, and CAN interfaces, with WiFi, Bluetooth, and cellular modem support. It also features TS-SILO for power backup and FRAM for reliable data storage.

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HOW EMERGING TECHNOLOGIES CAN TRANSFORM

EV battery reliability and safety

Above it all, battery developers and manufacturers need to be agile across the entire product lifecycle.

by Virginie Turc

Younger consumers, particularly Gen Z, say battery reliability, safety, and performance are important factors — more so than design and cost — when choosing an EV.

As U.S. automakers evolve their lineups with new electric and hybrid vehicles, they face a significant challenge: meeting the increasing demand for affordable, fast-charging, safer, and more reliable battery technology while also effectively scaling production. Notably, younger consumers, particularly Gen Z, now highlight battery reliability, safety, and performance as important factors beyond design and cost when choosing an EV.

To keep pace and ensure they are meeting expectations, battery developers and manufacturers need to be agile across the entire product lifecycle, quickly test and implement new approaches, and address consumer needs beyond just sticker prices.

To do this, manufacturers are turning to tools like AI, digital twins, and advanced battery chemistries. These advancements can help scale production, improve quality and safety, and reduce waste, all while helping reduce costs for the end-user and increasing the accessibility of EVs. By adopting these technologies, manufacturers can address the expectations of drivers while building increased demand for both hybrid and all-electric vehicles.

Advanced battery chemistries can tackle safety and reliability concerns

With safety and reliability as critical priorities, manufacturers are addressing concerns by shifting away from traditional nickel-manganese-cobalt (NMC) lithium-ion batteries. Instead, lithium-iron phosphate (LFP) batteries are gaining traction. While they offer lower energy capacity per volume compared to NMC, LFP batteries are more stable, affordable, and durable, enhancing lifetime performance.

Another promising alternative, solid-state batteries, uses a solid electrolyte instead of the highly flammable liquid found in conventional lithium-ion designs. This approach not only reduces fire risk but also enables greater energy density, enhancing both vehicle range and safety.

Notably, manufacturers are also adopting more sustainable production methods. Approaches like dry battery electrode manufacturing reduce reliance on toxic solvents and drastically cut energy

consumption, which reduces environmental impacts and operating costs — a key step toward a more sustainable EV ecosystem.

New battery technology begins with quality control

As battery technologies continue to evolve, so do approaches that ensure every battery meets the highest safety and reliability standards. Achieving this requires identifying safety issues during the manufacturing process before they become potential problems in the market.

Early detection and correction of errors — such as contamination, improper anode overhang, or hazardous pores in the housing weld seam — is critical to reducing the risk of failure. In the worst-case scenario, such failures could lead to thermal runaway over a battery's lifetime.

To meet these rigorous standards, EV leaders are adopting advanced quality control technologies like industrial CT scanning and non-destructive testing (NDT). These methods offer significant advantages over traditional testing approaches. For example, CT scanning provides detailed internal evaluations of each cell without causing damage, revealing issues such as anode misalignment, delamination, and foreign particles early in production. By catching these defects before they escalate, manufacturers can ensure safer, more reliable batteries.

How AI is playing a critical role in EV battery production

AI is proving to be essential in quality control processes and in enhancing the performance of next-generation batteries. Traditional quality checks, which rely on



As the EV market continues to evolve, so does the manufacturing and safety technology needed to meet consumer expectations and real-world challenges.

human review, can vary due to individual knowledge and human error. With AI, manufacturers can gain a sharper, more consistent focus on product quality. Through automated, AI-powered visual inspections, quality control becomes faster, more detailed, and capable of catching flaws that might otherwise go unnoticed, strengthening reliability.

Beyond inspection, AI-driven insights support predictive maintenance by analyzing EV battery data and usage patterns. This predictive approach enables manufacturers to monitor performance during initial cell formation, track key metrics like state of health (SOH), detect process variations that could affect cell safety

and efficiency, and meet sustainability standards.

AI's role extends to the design stage as well, where it assists in developing materials optimized for durability, performance, and sustainability. In this way, AI serves as a trigger and accelerator – not just in manufacturing quality control, but in the industry's broader push toward safer, more affordable, and environmentally sustainable EV solutions.

Bridging the innovation and efficiency gap with digital twins

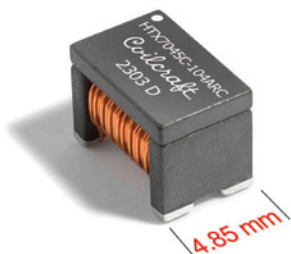
There is no denying that bringing a new battery to market can be a massively complex task, as R&D processes are lengthy and often require

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HOW EMERGING TECHNOLOGIES CAN TRANSFORM EV battery reliability and safety

BATTERY FEATURE

manual trial-and-error in laboratories. While AI elevates quality control and innovation, digital twins can play a similarly transformative role.

With digital twins, engineers can experiment with virtual electrode designs,

adjusting parameters like porosity, thickness, and more to fine-tune performance and prevent early failures – all without extensive physical testing. This approach streamlines R&D and reduces costs while optimizing battery design.

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LFP batteries are gaining traction with lower energy capacity per volume compared to NMC.

Digital twins also help streamline material usage and reduce waste, ultimately driving the development of lighter batteries that maintain reliability – further reducing costs for the end consumer.

Digital twins can also enable a virtual replica of the production line, helping workers analyze productivity and accelerate time-to-market. By simulating various shop floor layouts, manufacturers gain valuable insights for configuring production lines efficiently.

Finally, digital twins are essential for synchronizing workflows, machinery, and automated systems across production. In an industry with increased use of automation, aligning these operations helps manufacturers reduce downtime, enhance product quality, and meet rising production goals with agility.

The importance of exceeding expectations

As the EV market continues to evolve, so does the technology needed to meet consumer expectations and address real-world challenges. Battery production is just one piece of the larger EV adoption puzzle, it is clearly vital.

By addressing the needs of safety-conscious consumers through technologies like advanced chemistries, digital twins, AI, and rigorous quality engineering measures, manufacturers can position themselves as leaders in a rapidly evolving market. ■

**Virginie Turc is Battery and Energy Storage
System Business Development manager at
Hexagon Manufacturing Intelligence.**

JUAN ROBALLO/SHUTTERSTOCK.COM

2026 Escalade IQL is Cadillac's biggest, roomiest EV yet



In only four inches of increased overall length, the Escalade IQL offers noticeable improvements in passenger and cargo room.



The IQL gets the same massive front-dash screen surfaces and other luxury items as the (slightly) smaller Escalade IQ.

Cadillac has unveiled the 2026 Escalade IQL electric vehicle, which maintains the Escalade IQ's class-leading range but adds additional passenger and cargo space.

The company said space has improved for all three seating rows and the cargo space behind the third row. That area is created by stretching the Escalade IQL by more than four inches until its current length is 228.5 inches (5,803 mm). And the large eTrunk under the hood allows an additional 12.2 cu. ft. of storage.

Cadillac Global vice president John Roth said that with the larger model, the company “now offers a full lineup of internal combustion and all-electric Escalade options.”

The biggest bumps in passenger space come in the front

row, which sees an increase of more than an inch to 45.2 inches (1148 mm), and the third row, which, at 36.7 inches (933 mm), is 4.5 inches more than the IQ.

With the third seat in use, the cargo area offers 24.2 cu. ft. of space. It also jumps to 75.4 with the third row folded and a massive 125.2 with the second row folded. Those last two capacities are increases of 9% and 5%, respectively.

The IQL's nearly GMC Hummer EV-sized battery has a capacity of 205 kWh, a slight bump of 5 kWh. Cadillac is estimating 460 miles of range, about the same range as the shorter IQ. The company said that on a 240-volt Level 2 charger, the IQL will gain about 36 miles (58 km) of range for every charging hour. At a DC fast-charging public station, it can gain up to 116 miles (187 km) of range in 10 minutes.

The dual motors combine for 680 hp (505 kW) and 615 lb-ft (834 Nm) in normal mode and 750 hp (560 kW) and 785 lb-ft (1,064 Nm) in what Cadillac calls Velocity Max mode.

The IQL is jammed with the latest luxury display, audio and other technology. “With a commanding profile offering additional cargo capacity, the Escalade IQL is brimming with luxury features found on the Escalade IQ,” said Craig Sass, Cadillac's interior design manager.

For more about those features, see the October 2023 edition of *Automotive Engineering*.

Chris Clonts



All areas in the IQL see improved space, but the biggest differences are in the legroom of the front- and third-row seats.

2025 Nissan Murano: Variable compression to the mpg rescue

When it arrived in 2002, the Murano was the first crossover that **Nissan North America, Inc.** offered in the U.S. and Canada. The fourth-generation version went on sale last fall, and taking a short spin around Metro Detroit this winter proved that Nissan still knows how to make an appealing CUV that balances confident road feel and comfort with plenty of interesting tech under the hood and throughout the powertrain.

That hood sets the curve for a vehicle that's better proportioned than the outgoing model. Redesigned around Nissan's concept of energetic elegance, the new Murano now has thinner LED headlights and loses the pronounced chrome V in the grille. Overall, the look is indeed a bit more, well, elegant, which sets the stage nicely for the hidden improvements that follow.

The 2025 Nissan Murano uses a reworked version of the chassis from the outgoing model, which makes the updated powerplant the real story here. This one is another sort of Nissan first: a 2.0-L VC turbo engine, here mated with a 9-speed automatic transmission. The VC denotes that this was the world's first production variable compression engine when it debuted in the



The fourth-generation Nissan Murano arrives with new tricks from a variable-compression engine first seen in the 2019 Infiniti QX50.

2019 Infiniti QX50 SUV. At the time, Infiniti said developing the VC-T required more than 100 engine prototypes, more than 1.8 million miles of road testing, and more than 30,000 hours on test beds. In the QX50, the VC-T produced 268 hp (200 kW) and

280 lb-ft (380 Nm). The version in the 2025 Murano produces 241 hp (180 kW) and 260 lb-ft (353 Nm) and can tow up to 1,500 lb (680 kg). Compared to the 2024 Murano, the new model got an increase of 20 lb-ft (27 Nm).

Nissan has two main reasons for using the 2-L VC turbo engine over the 260-hp (194-kW), 3.5-L V6 that was used in the 2024 Murano, despite the engine's increased complexity. The first is that the VC produces more torque lower in the power band, giving the typical Murano driver more usable power in situations when they'll use it more. The second is that the engine offers a "massive improvement" in emissions in order to meet new regulations, including U.S. CAFE and global greenhouse gas standards. Idle stop-start is standard.



The 2025 Nissan Murano now has thinner LED headlights and loses the pronounced chrome V in the grille.

The Murano's efficiency improvements won't show up on the new window sticker, though. The 2024 and 2025 Murano models are both rated at 23 mpg, combined, but the new vehicle weighs 5,600 lb (2,540 kg), around 300-500 lb (136-227 kg) more than it did last year, depending on trim. The new Murano is also 2.6 in (66 mm) wider, at 87.7 in (2,228 mm), and has 8.3 in (211 mm) of ground clearance, 1.4 in (36 mm) more than before. The new Murano has 20-in standard wheels (18-in wheels were standard last year). Nissan said the fuel economy numbers almost hide how much of a difference the new engine makes, both by doing more work and better work. We'd see the hit to the new CUV's fuel economy numbers if it still used the V6, Nissan said.

Shifting to electric power steering Nissan engineers also focused their efforts on making the new Murano quieter and more comfortable. By switching from a hydraulic to an electric power steering system, the 2025 Murano doesn't only get ProPilot Assist (which requires an electric power steering system) but the Murano's steering wheel airbag module also acts as a damper to reduce vibration. The new system also offers a 4% faster steering ratio and 45% lower stationary steering effort compared to the previous generation, Nissan said. The new Murano also has increased structural rigidity, front to rear, thanks to additional structures in the grille, across the cowl and around the C-pillar.

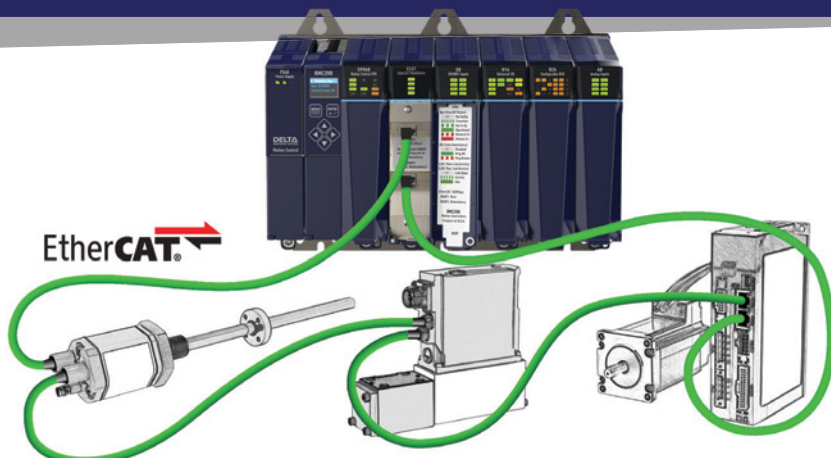
Engineers attacked low-frequency problem noises in the rear hatch area with new frequency-sensitive dampers made by KYB. KYB's proprietary technology means these aren't technically adaptive dampers, but they do use a frequency-sensitive valve inside the cylinder that opens and closes with different inputs. With high-frequency inputs (like small road vibrations), the dampers use a softer force to minimize the harshness, while they more dramatically stiffen up the suspension when faced with low-frequency inputs (undulations or larger bumps). As with

the rest of the changes Nissan made to the new Murano, the point was to improve the CUV's driveability, comfort and stability so they'd match what the target audience expects.

The new electric power steering and

dampers are immediately noticeable to anyone familiar with the 2024 Murano. The improved handling means the Murano can be larger and still feel reasonably responsive while threading a safe route through rush hour traffic.

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The 2025 Nissan Murano uses a reworked version of the chassis from the outgoing model, which makes the updated 2.0-L VC turbo engine the real story here.



The 2025 Murano's dashboard features dual 12.3-inch displays with a chunky dial to control the available 10-speaker Bose premium audio system.

There aren't many twisty roads near Detroit, but even so it was clear that the new Murano nails what it's going for. This is a competitive and comfortable gas-powered CUV with plenty of tech. There's standard Nissan Safety Shield 360, and ProPILOT Assist and Invisible Hood View are now available. The dash features dual 12.3-in displays with a chunky dial to control the available 10-speaker Bose premium audio system. Many infotainment controls

are on the screen, while the HVAC controls are haptic integrated sensors. The 2025 Murano is also the first with ventilated, massaging front seats.

All these engineering improvements make the 2025 Nissan Murano miles – if not “miles per gallon” – better than the 2024 version. Even without a slew of stand-out features to highlight, the Murano proves that sometimes all you need is a little bit more.

Sebastian Blanco

2025 Hyundai Ioniq 5 brings all the right updates

The place doesn't look like much: A Sonic drive-through in Cathedral City, California, and a row of eight Tesla Superchargers. But the 2025 **Hyundai Ioniq 5** I'm driving is helping to kick off a revolution in EV charging. The Korean automaker's popular SUV is the world's first non-Tesla to integrate a native North American Charging System (NACS) SAE J3400 plug, as most major automakers rush to ditch their CCS connectors in favor of Tesla's ubiquitous, ultra-reliable network.

With fingers crossed, I plug the pleasingly lightweight Supercharger plug – which pairs AC and DC links on a single connector – into the Ioniq 5's charging port, ignoring disdainful looks from a Model S driver next to me. After connecting via the Tesla app, the Ioniq 5 begins charging at a reasonable 126-kW.

We stuff the Ioniq 5's battery from 24% to 80% in 25 minutes, adding 147 miles (237 km) of driving range. That's faster than a Tesla Model 3 could manage, despite a key handicap that Hyundai is working to address: like other EVs with sophisticated 800-volt architectures, including Porsches and Lucids, the Hyundai's maximum charging rate is limited by Tesla's increasingly outdated V3 Superchargers, with their nominal 470 volts.

“We're working to boost that charging rate,” said Karl Holodnick, an engineering manager for power electronics at **Hyundai America Technical Center Inc. (HATCI)** near Ann Arbor, Michigan. Holodnick, riding shotgun in my car, says Hyundai engineers have developed a good working relationship with Tesla's Supercharger team, to ensure their Hyundai, **Kia** and **Genesis** EVs are compatible with Tesla's 17,000-strong Supercharging network. While the Model 3 can exceed the Hyundai's 126-kW pace for brief periods, Holodnick helped optimize software to deliver a more-robust charging curve overall.

Track down a CCS charger – Hyundai is giving CCS adapters to buyers to cover all charging bases – and the Ioniq 5 can charge at up to 257 kW, more than twice its pace on Superchargers and up from 233 kW for the 2024 model. The result is a zip-py 20-minute charge from 10-to-80%, versus 30 minutes (for Ioniq 5 Long Range models) on a Supercharger.

The NACS connector is the headline change for the Ioniq 5's mid-cycle refresh. It's designed to boost EV adoption that has slowed a bit, even as Americans bought a record 1.3 million EVs last year, up 8.3% from 2023. But Hyundai Motor Group, now second only to Tesla in U.S. EV sales, sought other ways to sustain momentum for its award-winning, handsomely angular SUV. Battery packs are now about 8% larger, with 63 or 84 kWh in Standard or Long Range models. Driving range jumps accordingly, including a maximum 318 miles (512 km) in



The NACS J3400 connector is the headline change for the 2025 Hyundai Ioniq 5's mid-cycle refresh.

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Red tow connectors and “digital camo” body cladding differentiate the XRT from other flavors of the updated Ioniq 5.

single-motor Long Range models.

Power output is unchanged, with a choice of 168 or 225 hp from the single-motor models, and 320 in AWD versions. But on an all-day drive near Palm Springs, the Ioniq 5 underscored the design and technology that’s made it one of the most successful main-

stream EVs: a space-efficient cabin, aided by a longer wheelbase than Hyundai’s beefiest SUV, the three-row Palisade. Lavish features, thoughtful design and craftsmanship. Brisk acceleration, a dead-quiet cabin and supple road manners.

The Hyundai’s four selectable levels

of brake regeneration remain a strong point that other EV makers should emulate, including a clever Smart mode that automatically adjusts regen based on radar sensing of cars ahead.

The Ioniq 5’s strikingly conjoined display screens grow slightly larger at 12.3 inches per screen, with faster processing

The 2025 Ioniq 5 goes back to basics with a new row of hard switches in the center console for things like seat heaters, audio volume and tuning knobs.



BOTH IMAGES: HYUNDAI



The 2025 Ioniq 5 XRT has 18-inch wheels and all-terrain 235/60R18 tires to take advantage of the EV's Sand, Mud, and Snow drive modes.

speeds, more-accurate GPS and improved OTA update capability. Hyundai's Level 2 driver assist systems, already a top performer among mainstream brands, work even better. The Ioniq 5 worked with impressive precision on highways, with none of the ping-ponging between lane markers that mars some competing systems. The driver-assistance suite adds a driver-monitoring camera with hands-on detection and haptic alerts through the steering wheel.

This 2025 version bucks button-free trends by adding a row of hard switches to its sliding center console, for seat heat and other functions, along with new audio volume and tuning knobs. New pixelated LED lights on the steering wheel flash to show charging progress. And stop the presses: There's now a rear window wiper, addressing serial complaints from owners in wintry climes.

Hyundai already offers a rollicking Ioniq 5 N that delivers up to 641 hp, and a fun-to-drive quotient that tops many

pricier EVs. For 2025, Hyundai cast its sights off-road – or at least camping trails or icy driveways – with a new XRT model with sturdy 18-inch wheels that recall the “steelies” of old. All-terrain tires, drive modes for Sand, Mud and Snow, a 1-inch (25 mm) body lift and handsome “digital camo” body cladding round out the package. We drove the XRT through some desert washes and gullies near Palm Springs

A 2025 Ioniq 5 can be had for as little as \$43,975, and tops out at \$59,575 for a Limited AWD version. And where the Ioniq 5 had been shut out of consumer tax credits due to its Korean manufacture, that may well change. Later this year, Hyundai will switch Ioniq 5 production to its sparkling, \$7.6 billion “Metaplant” in Georgia. Company executives are confident the homegrown Ioniq 5 will qualify for a full \$7,500 tax credit — for as long as credits last, with the Trump administration determined to eliminate public support for EV purchases or public charging.

Lawrence Ulrich

2025 Toyota 4Runner: Capable across the lineup

The sixth-generation 4Runner, **Toyota's** serious and accessible off-roader, is built at the Tahara Plant in Japan. That's important because Tahara is also where Toyota builds the Land Cruiser, providing familiarity with SUV manufacturing. (The Land Cruiser is no less serious an off-roader, but given that it starts at \$56,700 and the 4Runner \$40,770, there is a difference in accessibility.)

Toyota also builds the new **Lexus GX**, the third generation version with off-road capability that launched last year, at Tahara. But there's something even more notable about the 4Runner and the Tahara-built SUVs as well as the Toyota Tacoma, Tundra and Sequoia. All these vehicles are based on Toyota's TNGA-F platform.

Solid structure

When engineering a vehicle that has the body rigidity necessary to handle the torques created by off-road forces while accommodating the daily drives, frame and suspension setups are paramount.

The 4Runner has a boxed high-strength steel ladder frame. While that in and of itself isn't particularly unusual for off-road-oriented vehicles, what is different here is that Toyota is using laser-tailored blanks to produce the structure. Essentially, the components are produced with varying alloys and gauges, specifically adding thickness only where required in order to provide the level of performance needed. The 4Runner features a multi-link coil rear and double wishbone front suspensions.

Why body-on-frame?

There is something else that the 4Runner, Land Cruiser, Tacoma, Tundra, and Sequoia have in common: All these vehicles were developed under the direction of chief engineer Keita Moritsu. Moritsu has been working on TNGA-F-based products since 2017.

One of the distinctive characteristics of the 4Runner since its introduction

in model year 1984 is that frame. While competitors like the **Nissan** Pathfinder started with that architecture, they have since transitioned to unibody structures.

Moritsu said that while that change was made to deal with CAFE requirements, “Body-on-frame is one of the roots of Toyota, part of our culture, so we continue with it,” he said. He also pointed

to another reason why Toyota continues to build the vehicle that way: it’s what 4Runner buyers want.

Powertrain offerings

The body-on-frame choice should not indicate any indifference on Toyota’s part as regards CO2 emissions: the 2025 4Runner is available with two different powertrain configurations. The i-Force version uses a 2.4-L turbo-charged four-cylinder engine with output of 278 hp (207 kW) and 317 lb-ft (430 Nm). Then there is the i-Force Max, which supplements the 2.4-L engine with a 48-hp motor integrated into the eight-speed automatic transmission. The hybrid produces 326 hp (243 kW) and 465 lb-ft (630 Nm).

The hybrid is available only in models that feature 4WD. The EPA-estimated fuel economy numbers for the i-Force Max are 23 mpg city, 24 highway, and 23 combined.

Various i-Force trims offer either 19 mpg city, 25 highway, and 21 combined or 20 city, 24 highway, and 21 combined. So the hybrid provides overall better fuel economy and both permit towing of up to 6,000 lbs (2,722 kg). Moritsu said that one of the features he likes about the hybrid is that there is more linear acceleration than that provided by the engine without the electric motor supplement.

Variety, not minimization

While there is a trend toward complexity reduction in the auto industry – which typically manifests itself in reduced trim-level offerings – that’s not the case with the 4Runner. The SUV is offered in nine grades, everything from the entry-level SR5 to Platinum, to an array of models that are built for off-road performance, like the Trailhunter, which comes standard with Old Man Emu 2.5-inch forged monotube shocks, and the TRD Pro, which has FOX Q53 internal bypass shocks with 2.5-inch aluminum housings and rear remote reservoirs as well as RIGID Industries LED foglamps.

When asked about this variety of model offerings, Moritsu says the decision was



2025 Toyota 4Runner TRD Pro model. Designed in Michigan. Engineered and manufactured in Japan.



The 2025 Toyota 4Runner is available with a hybrid powertrain that uses a 2.4-L turbo four mated with a 48-hp motor.



Aside from the TDR, the 2025 Toyota 4Runner line-up also includes the Limited (seen here in Heritage Blue) and Trailhunter (here in Everest) trims, among other versions.

made because Toyota wants to address the needs of a wide range of 4Runner loyalists and potential new ones.

Heritage Meets Tech

In fact, there was a determined effort made to maintain a thread of “4Runnerness” from the first generation to the sixth. For example, the side glass behind the C-pillar maintains a trapezoidal shape. And, more significantly, the power rear window. Moritsu explained this was something that 4Runner owners found to be an endearing characteristic. But he said that providing the motors and mechanisms that allow the glass to move added mass to the vehicle, which meant that they had to work to offset that mass. Engineers reduced mass in the frame through the use of the tailor-welded blanks, as well as an aluminum hood.

The 4Runner is essentially a North American-centric vehicle, with exterior styling led by the **CALTY** design team in Michigan (also involved in the design of the current-generation Tacoma). Although there are differences (e.g., the front-end configurations), Moritsu acknowledged that the 4Runner and Tacoma are common from the B-pillar forward.

The 4Runner offers a range of tech, including a 14-inch multimedia touchscreen (particularly handy when front cameras are activated off-road so you can see both sides of the vehicle as well as what’s going to appear once you crest that hill), the camera- and radar-based Toyota

Safety System 3.0, Apple CarPlay and Android Auto, and more. The many 4Runner loyalists out there can rest easy, knowing they can get an updated vehicle but still add everything from ARB roof racks to steel skid plates to transfer cases and rear differential protectors.

Gary S. Vasilash



Like previous generations, the sixth gen has powered rear glass. Chief engineer Keita Moritsu says that to accommodate the additional mass, they took countermeasures, like using an aluminum hood. Note also the trapezoidal glass on the body side, another nod to earlier 4Runners.

Structural Adhesives for Metal Bonding



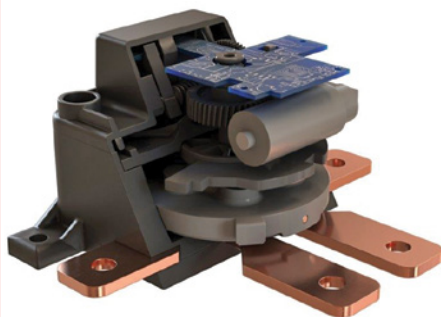
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SPOTLIGHT: BATTERY MANAGEMENT

Battery switches



Eaton (Southfield, Michigan) released a battery configuration switch designed for automotive, commercial and UTV applications.

Eaton states that their BCS enables the reduction of up to 12 components in a battery disconnect unit, simplifying the system and streamlining packaging and assembly. The BCS also reportedly minimizes contact resistance, enhancing overall system efficiency and performance by reducing the number of contact points required by conventional contactors. The BCS has a mechanical interlock that prevents pack short circuits due to crashes, software bugs, or contactor malfunctions. The BCS can also maintain stable conditions when the electronic control unit loses power. Its bi-stable nature enhances efficiency during normal operations by eliminating the hold current of a traditional contactor.

<https://www.eaton.com>

Click Boards

MIKROE (Belgrade, Serbia) launched Click Shield for FRDM-MCXN947, an expansion device for the NXP development board. The shield provides three mikro-BUS sockets, enabling designers to prototype and develop using multiple Click boards. The FRDM-MCXN947 is a microcontroller board based on the MCX N947 microcontroller. It integrates the Arm Cortex-M33 TrustZone core, CoolFlux BSP32, and PowerQuad DSP Co-processor, operating at 150MHz. Ideal for consumer IoT, smart appliances, industrial control and automotive accessories, it features Hi-Speed USB, CAN 2.0, and 10/100 Ethernet. The board includes an on-board MCU-Link debugger, FlexIO for LCD control, and dual-bank flash for read-while-write operations, supporting large external serial memory configurations. The FRDM-MCXN947 development board and expansion shield with Click boards suit a wide variety of applications such as consumer IoT, smart appliances, industrial control and automotive accessories.

<https://www.mikroe.com>



Connectors

Heilind Electronics, (Wilmington, Massachusetts) announced the MX150 series from Molex. Available in both pass-through and mid-voltage configurations, these connectors are designed for automotive electrical and industrial applications. The MX150 pass-through sealed connector system is IP67-rated for dust and water resistance. Connector position assurance and terminal position assurance are available on MX150 series connectors to confirm and maintain secure mating. With an oil-resistant design, these connectors are well suited for oil-cooled electric motors. The MX150 series is available in various circuit sizes and connector formats to meet increasingly demanding space constraints in automotive designs. An MX150 mid-voltage connector series is also available to adapt existing MX150 form factors to accommodate new 48V wiring architectures for lighting, power windows, wiper motors, and more.

<https://www.heilind.com>



Automotive IGBTs

ROHM Semiconductor (Santa Clara, California) announced new automotive-grade AEC-Q101 qualified 4th Generation 1200V IGBTs that combine low loss characteristics with high short-circuit resistance. This reportedly makes the devices ideal for vehicle electric compressors and HV heaters, as well as industrial inverters. The current lineup includes four models (RGA80TRX2HR, RGA80TRX2EHR, RGA80TSX2HR, RGA80TSX2EHR) in two discrete package types (TO-247-4L and TO-247N), along with 11 bare chip variants (SG84xxWN) with plans to further expand the lineup in the future. These devices achieve a short-circuit withstand time of 10μs (Tj=25°C), together with low switching and conduction losses, while maintaining a high withstand voltage of 1200V and meeting automotive standards by reviewing the device structure, including the peripheral design.

<https://www.rohm.com>



Graphics Suite

Microchip Technology (Chandler, Arizona) announced the Microchip Graphics Suite, a comprehensive solution that simplifies the process of incorporating GUIs, animations and images into a touchscreen display. The solution features Microchip's 32-bit microcontrollers and microprocessors and supports multiple development platforms, including MPLAB Harmony v3 and Linux environments. This solution to build a GUI interface aims to help designers improve reusability across projects and simplify design complexities. MGS also offers compositional tools, including a simulator for hardware-free prototyping. By leveraging the MPLAB Code Configurator (MCC), the simulator builds the MCC-generated C code in either web or native mode. In web mode, the tool creates an HTML file that can run on most web browsers with simulated touch interactivity.

<https://www.microchip.com>



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E-Axes

Renesas Electronics (Tokyo, Japan) announced its “8-in-1” proof of concept for E-Axle systems which controls eight functions using a single microcontroller.



Developed in collaboration with **Nidec Corporation** (Kyoto, Japan) this PoC integrates a motor, a reduction gear, inverter, a DC/DC converter and an on-board battery charger. The inverter from Renesas has a 70-100kW output performance with the maximum efficiency of 99% or higher; a 1.5kW output DC/DC converter, a 6.6kW charge OBC; a power distribution unit (PDU); a battery management system (BMS); and Positive Temperature Co-efficiency (PTC) heater control. While generally each function of an E-Axle requires a dedicated MCU and a power management IC (PMIC) to control an X-in-1 system, Renesas successfully implemented a new E-Axle system which can operate with only one MCU and a PMIC to control the entire 8-in-1 system.

<https://www.renesas.com>

Power Supply ICs

Power Integrations (San Jose, California) introduced a new member of its InnoMux-2 family of single-stage, independently regulated multi-output offline power supply ICs. The new device features a 1700 V gallium nitride switch, fabricated using the company's proprietary PowiGaN technology. The 1700 V InnoMux-2 IC supports 1000 VDC nominal input voltage in a fly-back configuration and achieves over 90% efficiency in applications requiring one, two or three supply voltages. Each output is regulated within 1% accuracy, eliminating post regulators and further improving system efficiency by approximately 10%. The new device replaces expensive silicon carbide (SiC) transistors in power supply applications such as automotive chargers, solar inverters, three-phase meters and a wide variety of industrial power systems.



<https://www.power.com>

Power MOSFETs

Littelfuse (Chicago, Illinois) announced the launch of its TPSMB Asymmetrical TVS Diode Series specifically designed for the protection of Silicon Carbide (SiC) MOSFET gate drivers in automotive applications. This innovative product addresses the increasing demand for reliable overvoltage protection in next-generation electric vehicle (EV) systems, delivering a compact, single-component solution that replaces multiple Zener diodes or TVS components traditionally used for gate driver protection. The unique asymmetrical design of the TPSMB Series supports SiC MOSFETs differing positive and negative gate driver voltage ratings, ensuring enhanced performance in a variety of demanding automotive power applications where SiC MOSFETs are used, including on-board chargers, EV traction inverters, I/O interfaces and Vcc buses.



<https://www.littelfuse.com>



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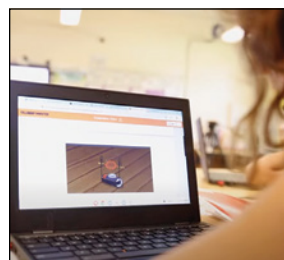
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Siemens senior director for battery industry: Industrial AI is coming

Siemens is working to make industrial AI a reality. But, to integrate generative AI into industry, the AI has to be trained on the language of industry – engineering and manufacturing languages – not just the modalities of text and speech and images. We spoke with Puneet Sinha, senior director, battery industry, for Siemens Digital Industries Software.

You said you train AI on these industrial languages. How do you do that? What is the information you're feeding into the model?

Our focus is to train large language models, not only on the current modalities. So, for example, how will AI train on CAD data? How can it understand the manufacturing processes that are happening or the business processes that are happening.

In the industrial world, there are rightful questions about who can access certain data within a company or at a supplier. And if you are going to use AI to enhance digital twin technology creation or the execution of it, there should be minimal hallucinations. They should be trained on the business processes and engineering processes and language of that company.

So some of the things that we are heavily investing is how we can bring retrieval-augmented generation in our portfolio. We are implementing that with Teamcenter, which is our PLM platform, so that not only can companies train and leverage the generative AI, but they can also do it on their business processes, and they can control who can access that data. Those are the elements of industrial AI.

AI retrieves data sort of how we create memories, through re-creation. Is that reliable enough in an industrial setting? You said it has

to have minimal hallucinations, but wouldn't you need that to be zero?

Yes, absolutely. Siemens is looking at how we can bring the power of AI so that companies can actually make decisions with it, being confident that they are not having hallucinations. We are getting a lot of customers using comprehensive digital twins for battery. In simulation, you can account for all these domains –

mechanical, electrical, electronic, material, software, system – and the tradeoffs, what is the implication of the chemistry or how it needs to be cooled or the safety implications. There are simulation suites that we have that account for all of those things.

When designing, especially during validation in terms of how it needs to be cooled, what the thermal management strategy needs to be, how the battery pack needs to be charged, and fast charging strategy, all of that can be now done in a really short time, leveraging the power of generative AI that is trained with the not only with the testing data, but also synthetic data coming from simulations, and that is helping engineers to explore new designs and validate designs against various requirements in a really short time.

Do you see automotive engineers using AI more to reduce development time or to explore more options?

It is absolutely a combination of two. We now have embedded these, you can think of them chat bots, in our simulations. If companies have done simulations, let's say at the system level, rather than recreating a lot of those results or extracting new analysis, engineers can easily interact with the software, asking, 'If that battery is used, what is the range going to be for these different driving styles?' It's a lot more interaction, so you can generate a lot more analysis more naturally.

Sebastian Blanco



Puneet Sinha, senior director, battery industry, Siemens Digital Industries Software.

“AI should be trained on the business processes and engineering process and language of that company.”

WEBINARS

ACCELERATE BATTERY SIMULATIONS WITH SURROGATE MODELS

Wednesday, April 30, 2025 at 1:00 pm U.S. EDT

Battery modeling can be greatly sped up by building simulation apps that contain surrogate models. Whereas the detailed Newman model provides accuracy at a significant computational cost, lumped models are faster but less accurate. For cases that call for both accuracy and speed, surrogate models are worth considering. This 60-minute webinar will discuss the tradeoff of complexity versus speed of results as well as how battery applications may benefit from surrogate models.

Speaker:



Rasmus Karlsson, Ph.D.
COMSOL

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NAVIGATING SECURITY IN AUTOMOTIVE SoCs: HOW TO BUILD RESILIENT SOLUTIONS

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In today's rapidly evolving automotive industry, ensuring the security of vehicles has become more critical than ever. Vehicles have become increasingly connected and autonomous, automotive OEMs are looking to centralize the hardware components in their vehicles, and software is becoming more complex due to artificial intelligence and machine learning. This 60-minute webinar delves into the latest advancements, challenges, standards for safety, and best practices in safeguarding modern vehicles from cyber threats.

Speakers:



Ron DiGiuseppe
Automotive
Segment Marketing
Manager,
Synopsys



Dana Neustadter
Senior Director
– Product
Management
Security IP,
Synopsys

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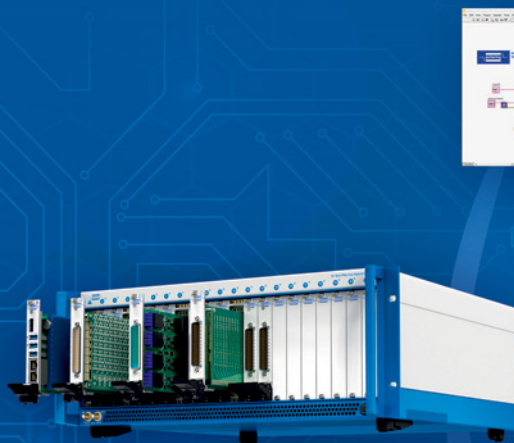
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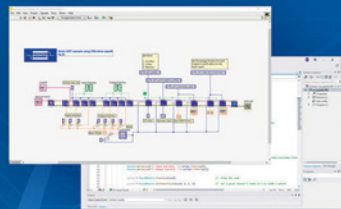


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